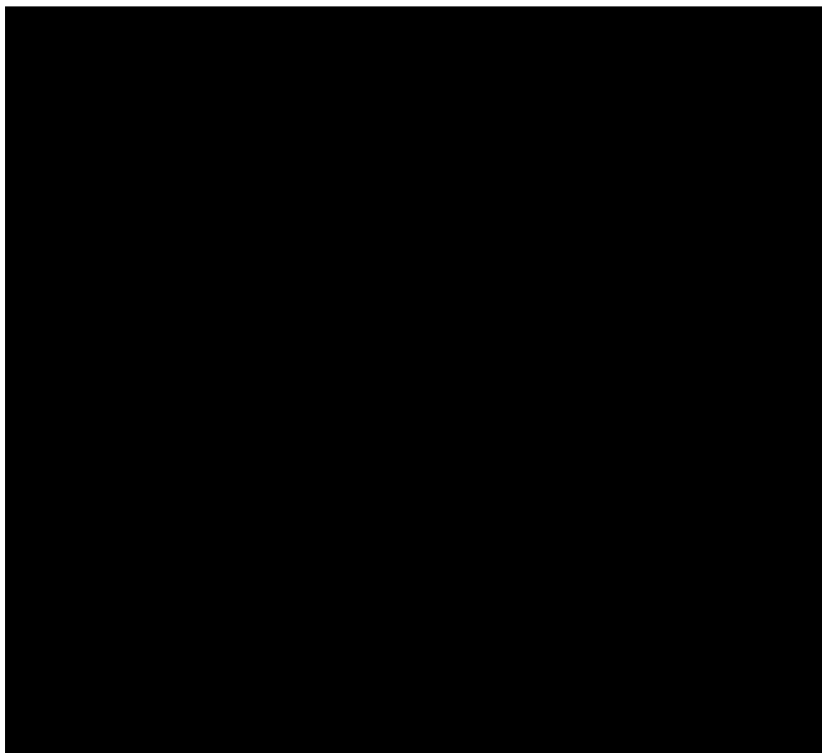


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REPORT 974-002

DETERMINATION OF THE FORCE REQUIRED
TO BEND FILM 180 DEGREES
OVER DIFFERENT RADII OF CURVATURE

RM-134-65


February 1965

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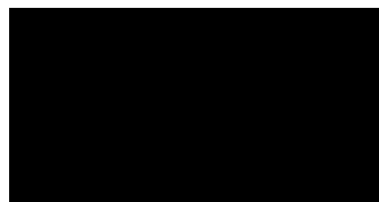


FOREWORD

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 submits this report in compliance with Item 4.2 of the Development Objectives of Contract 974. This report should be read in conjunction with Report 974-000 of which it forms a part.

Approved:



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ABSTRACT

This report presents the results of investigations conducted to determine the force required to bend film 180 degrees over different radii of curvature. The tests were carried out as part of a series necessary to establish design criteria essential to the development of the liquid/air bearing concept of film processing.

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SECTION 1 - INTRODUCTION

In a liquid/air bearing type of film processor, the objective is to transport the film from the load end to the takeup end without mechanical contact between the film and the machine. This objective is attained by providing stationary sleeves in place of rollers in and between the tanks. Air, or the fluid in the tanks, is pumped into the sleeves and ejected at sufficient velocity and pressure to form a continuous cushion between the film and the bearing. The film is transported over this continuous cushion free of mechanical handling and with low tension on the film. Two main criteria are necessary to determine the cushion loads and capstan torque requirements: (1), the coefficient of friction of the film (film drag load) and (2), the additional tension required to bend the film around the bearings. This report determines the values of the latter parameter.

SECTION 2 - TECHNICAL DISCUSSION

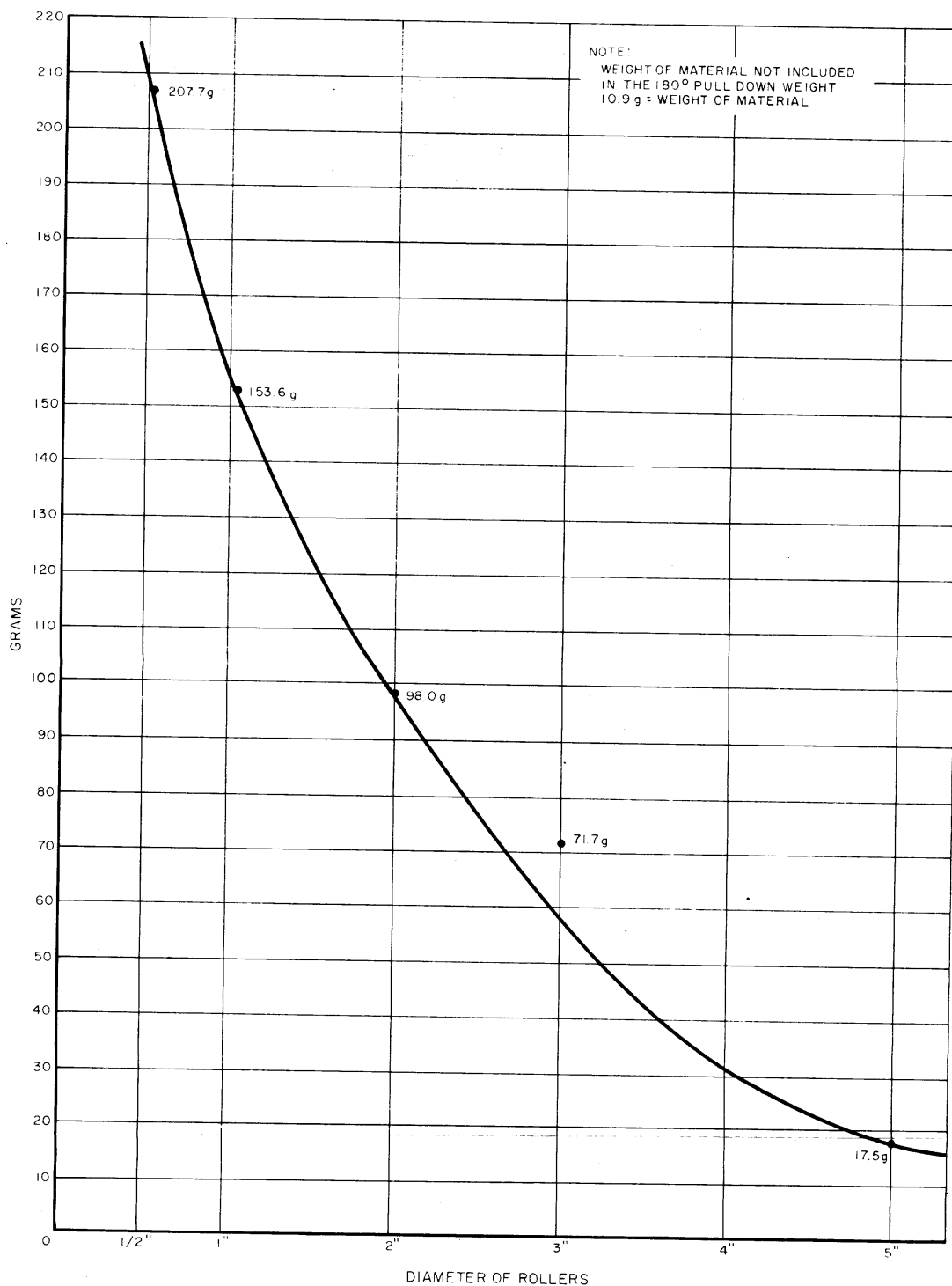
To obtain the values of the loads, a framework was constructed in which rollers were mounted as required. The diameters of the rollers used were 1/2, 1, 2, 3, and 5 inches. These diameters were selected as those giving a sufficient number of points for the plotting of a curve for each film thickness. A 15-inch length of each film sample was hung over each diameter of roller and weights were added until the film touched the roller over an angle of 180 degrees. New, dry, unprocessed film was used. The film tested was in 35mm, 70mm, 5-inch, and 9-1/2 inch widths, with base thicknesses of 0.00257, 0.0056, and 0.0085 inch.

The results obtained show that each test yielded a real half of a hyperbola, and that the break in the curves occurred for a diameter of 5 inches or greater.

SECTION 3 - CONCLUSIONS

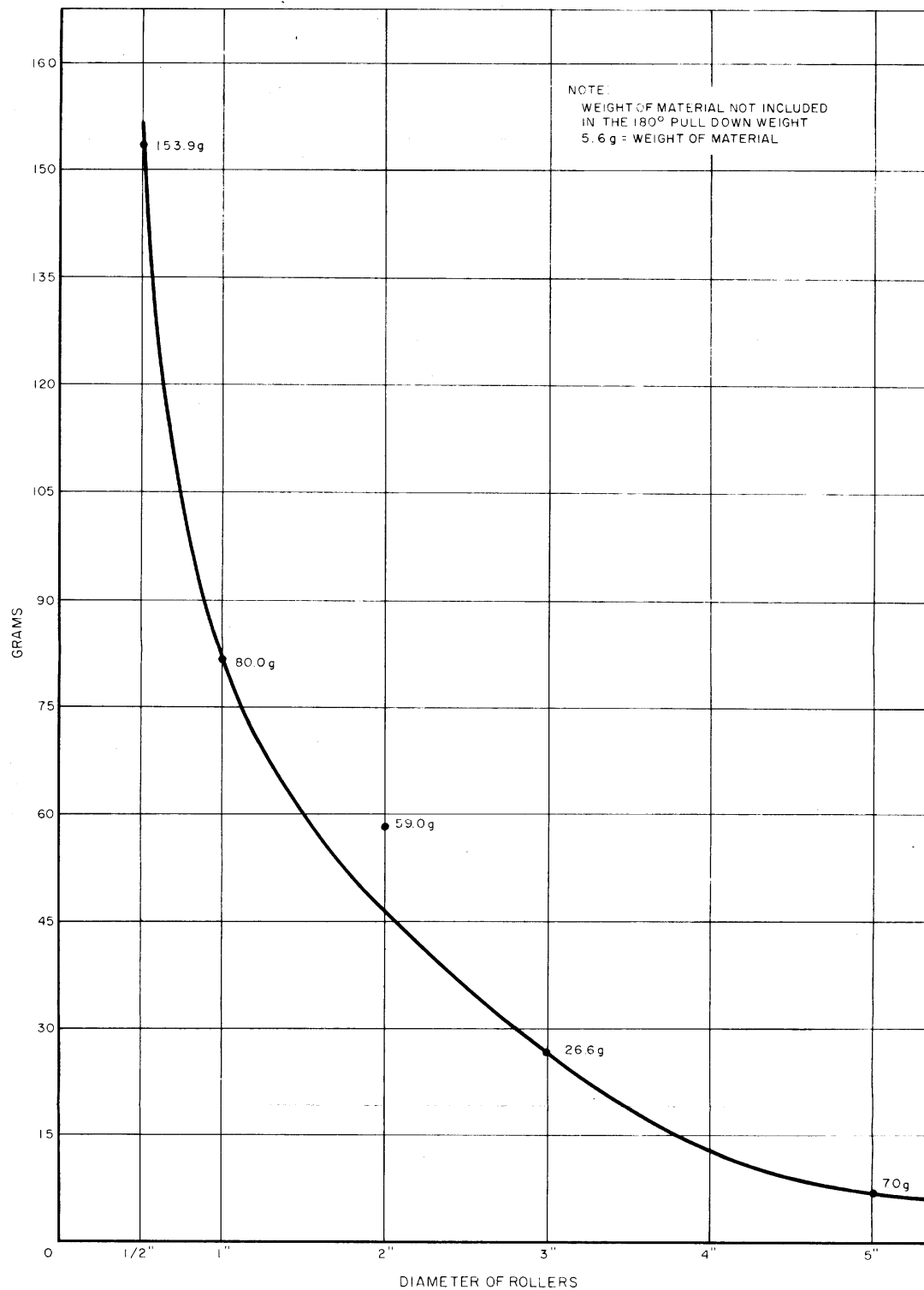
Based on the dry film values obtained, it is concluded that capstans and bearings should be designed with a minimum diameter of 5 inches to minimize total film tension and maximum bearing and capstan loads. Where circumstances permit, bearings of even larger diameter should be used.

To give a design example, a processor using thirty-seven 1-inch diameter bearings (assuming use of 2.57 mil thin-base film, Figure 2-1) would require a total force of 153.6 grams x 37, or 12.5 pounds. Selection, in the same machine, of 5-inch diameter bearings would result in a total force of 17.5 grams x 37, or 1.43 pounds. This produces a significant reduction in film tension, bearing cushion loads, and drive capstan torque.



S.O. 1188 9-1/2" x 15" THIN-BASE FILM
2.57 MILS - THICKNESS OF MATERIAL
UNPROCESSED

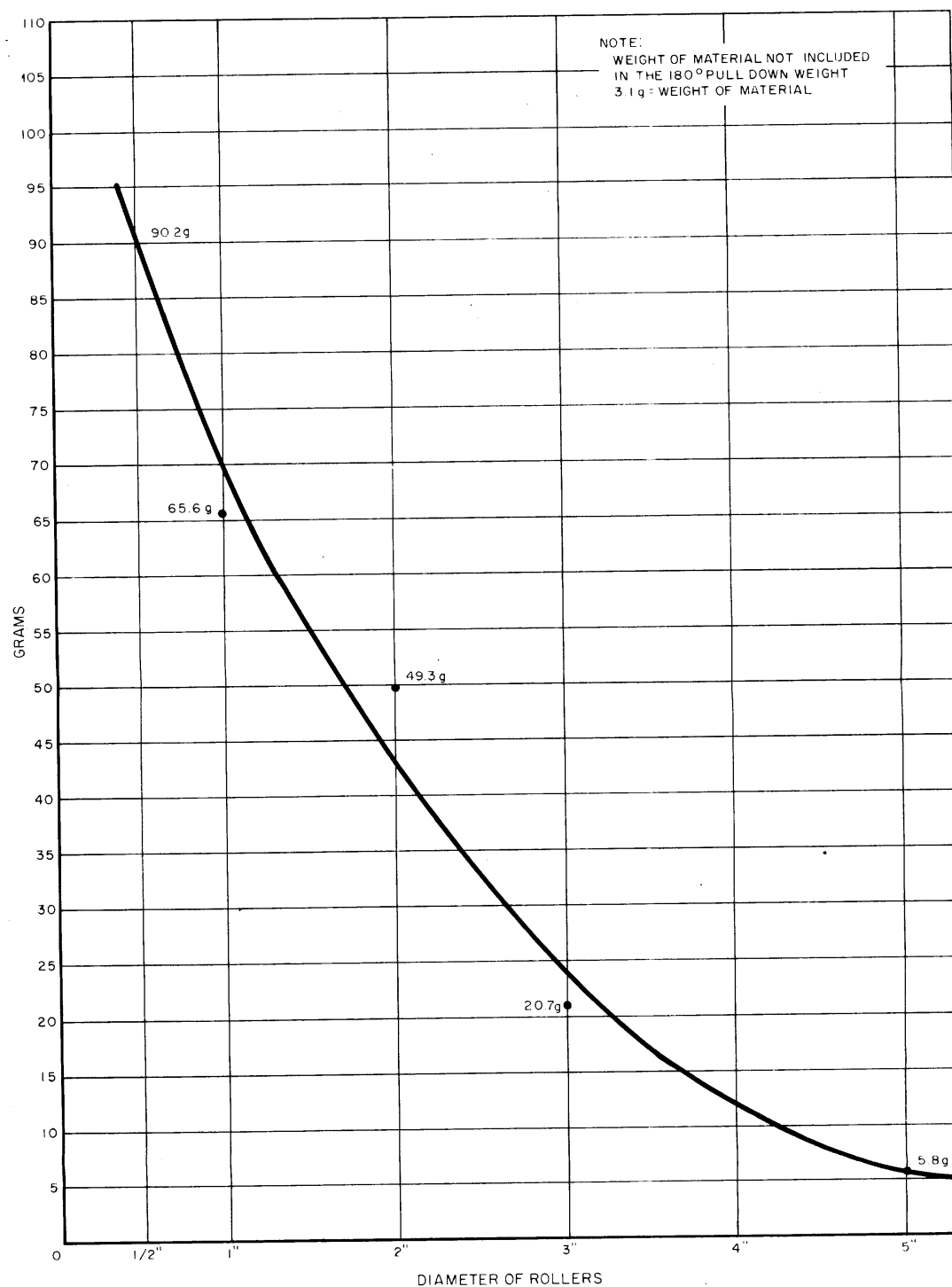
Figure 1.



S.O. 1188 5" X 15" THIN-BASE FILM
2.57 MILS - THICKNESS OF MATERIAL
UNPROCESSED

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Figure 2.

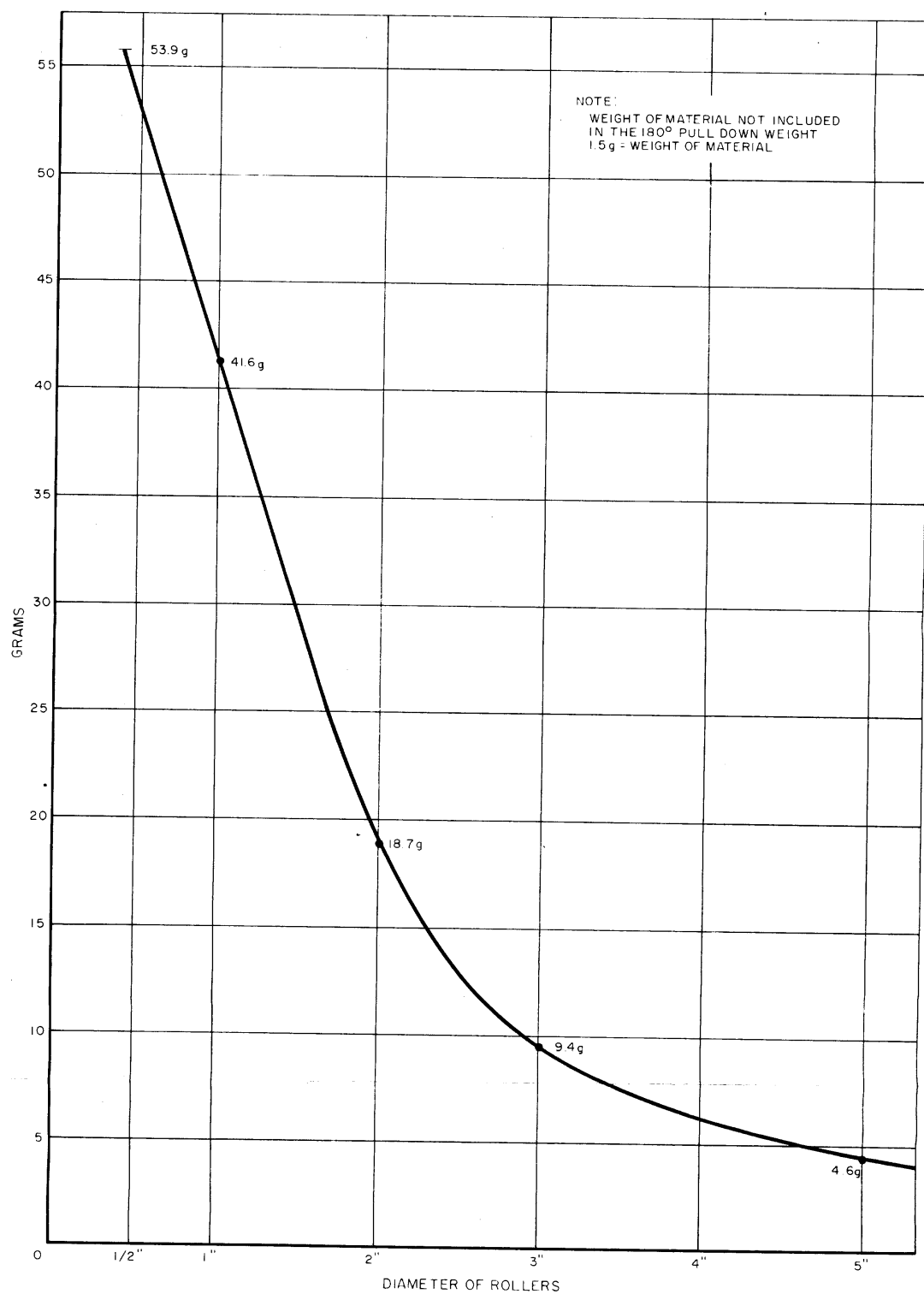


S.O. 1188 70 MM X 15" THIN-BASE FILM
2.57 MILS - THICKNESS OF MATERIAL
UNPROCESSED

Figure 3.

5

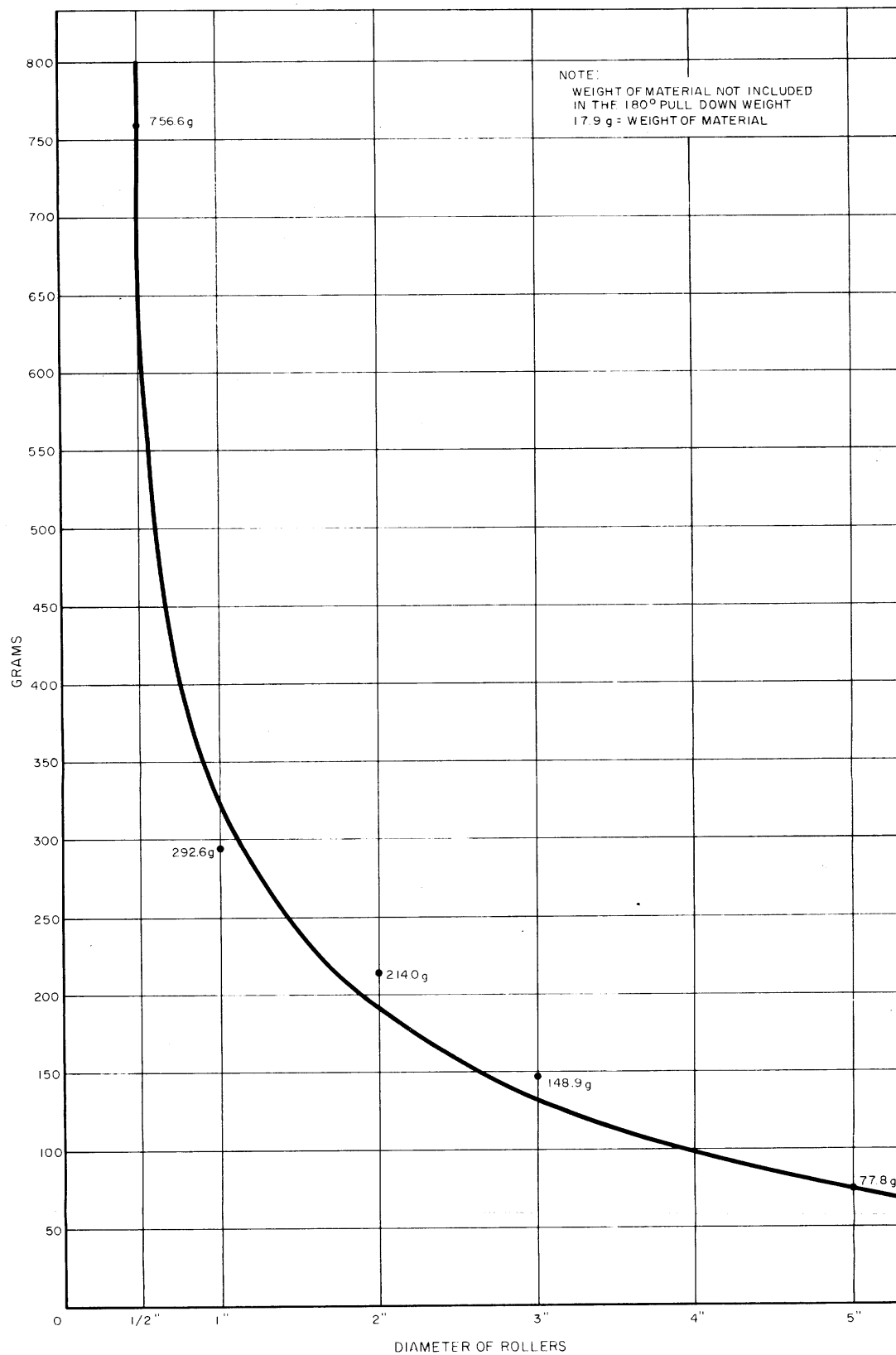
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S.O. 1188 35 MM X 15" THIN - BASE FILM
2.57 MILS - THICKNESS OF MATERIAL
UNPROCESSED

Figure 4.

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TYPE 8430 9-1/2" X 15" MED-BASE FILM
5.6 MILS - THICKNESS OF MATERIAL (BASE ONLY)
UNPROCESSED

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Figure 5.
7

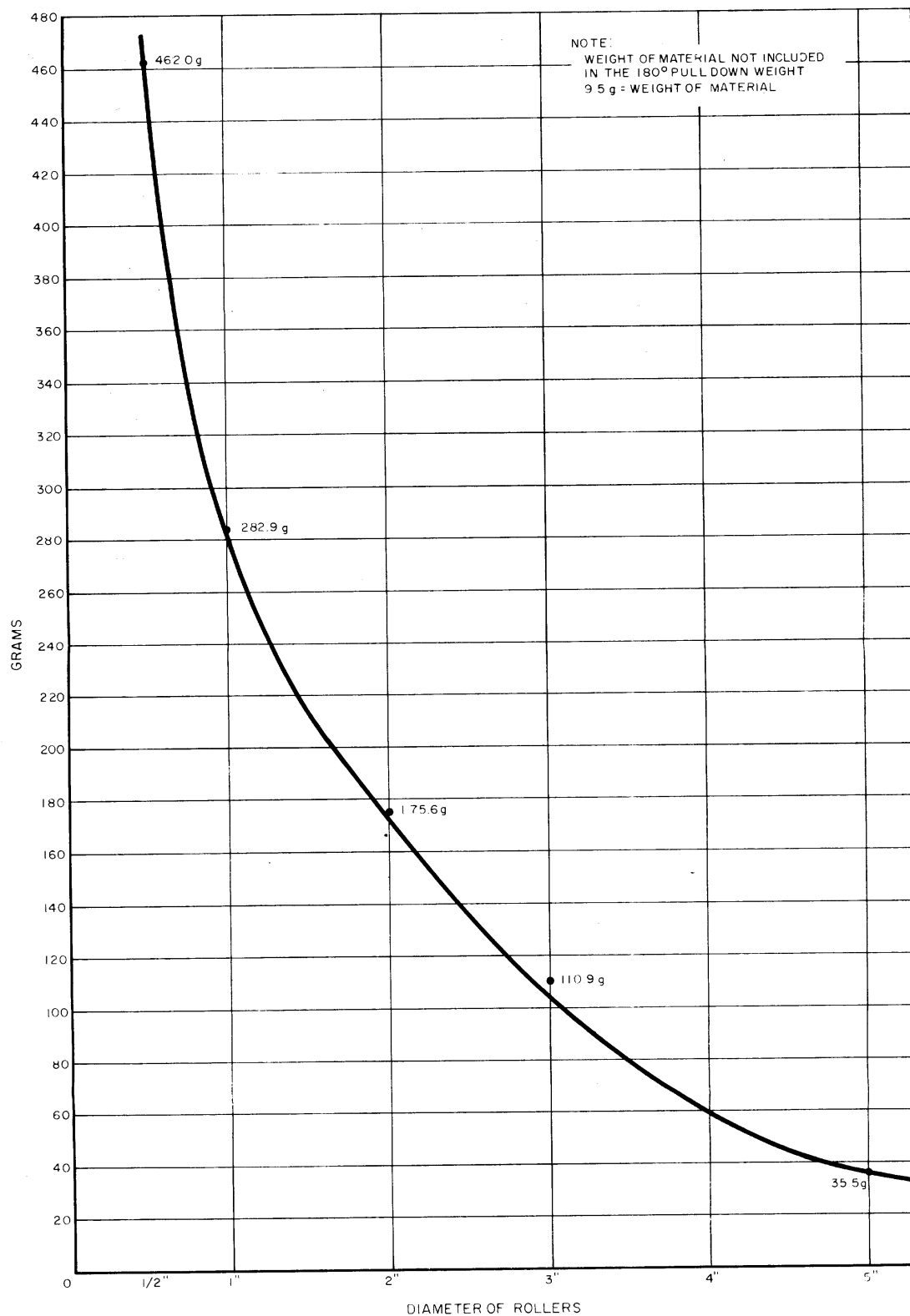
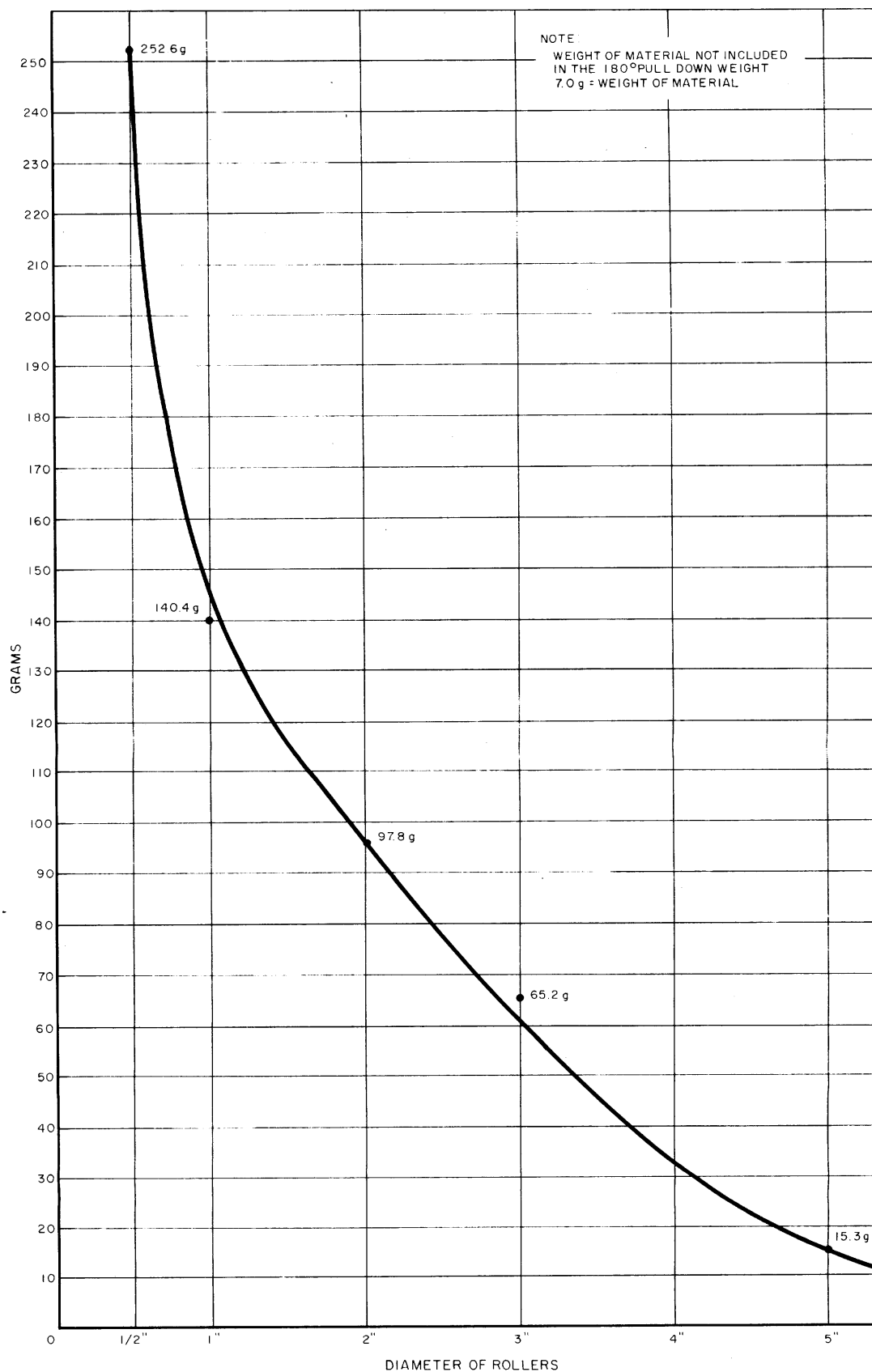


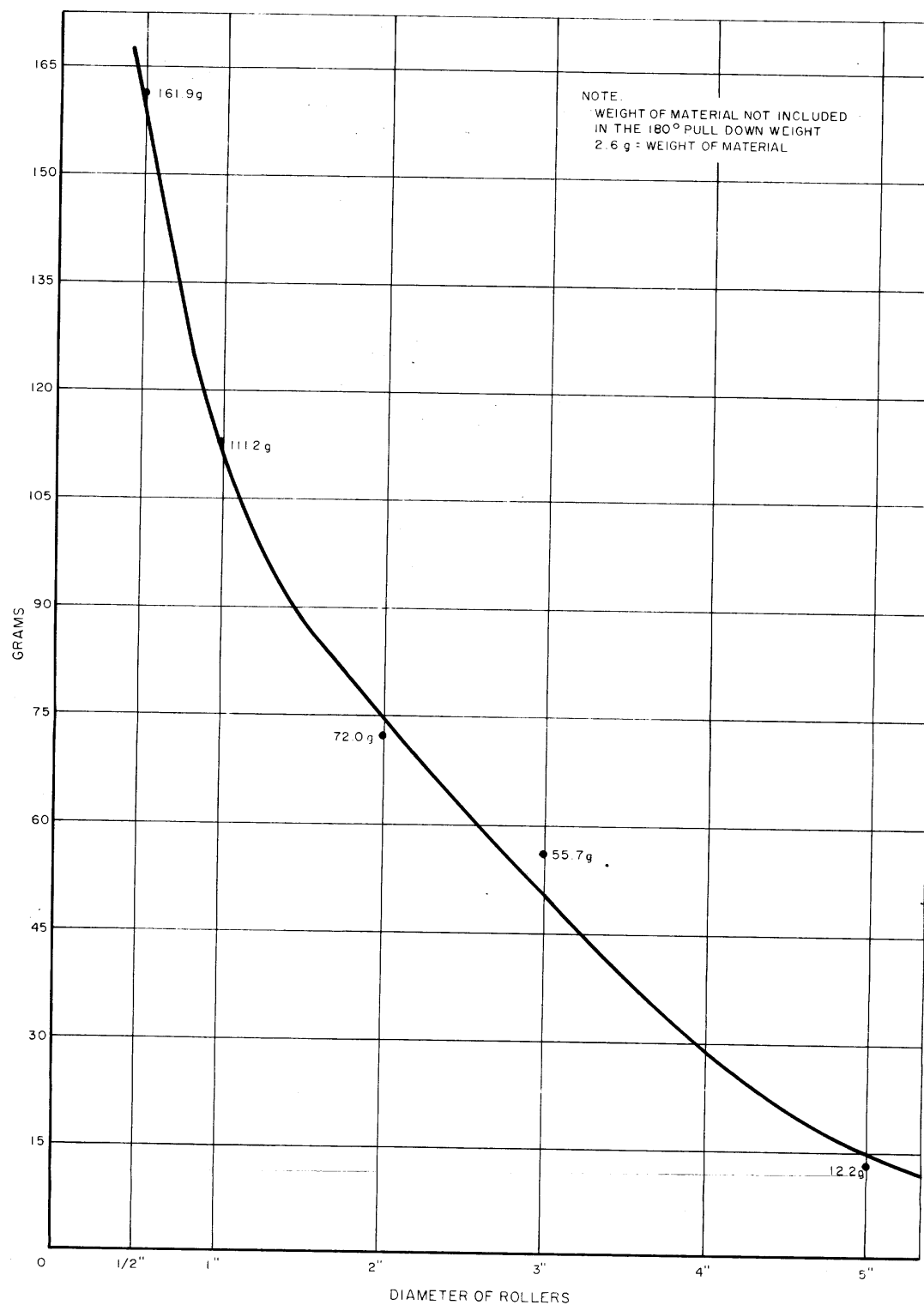
Figure 6.

TYPE 8430 5" X 15" MED-BASE FILM
5.6 MILS - THICKNESS OF MATERIAL
UNPROCESSED



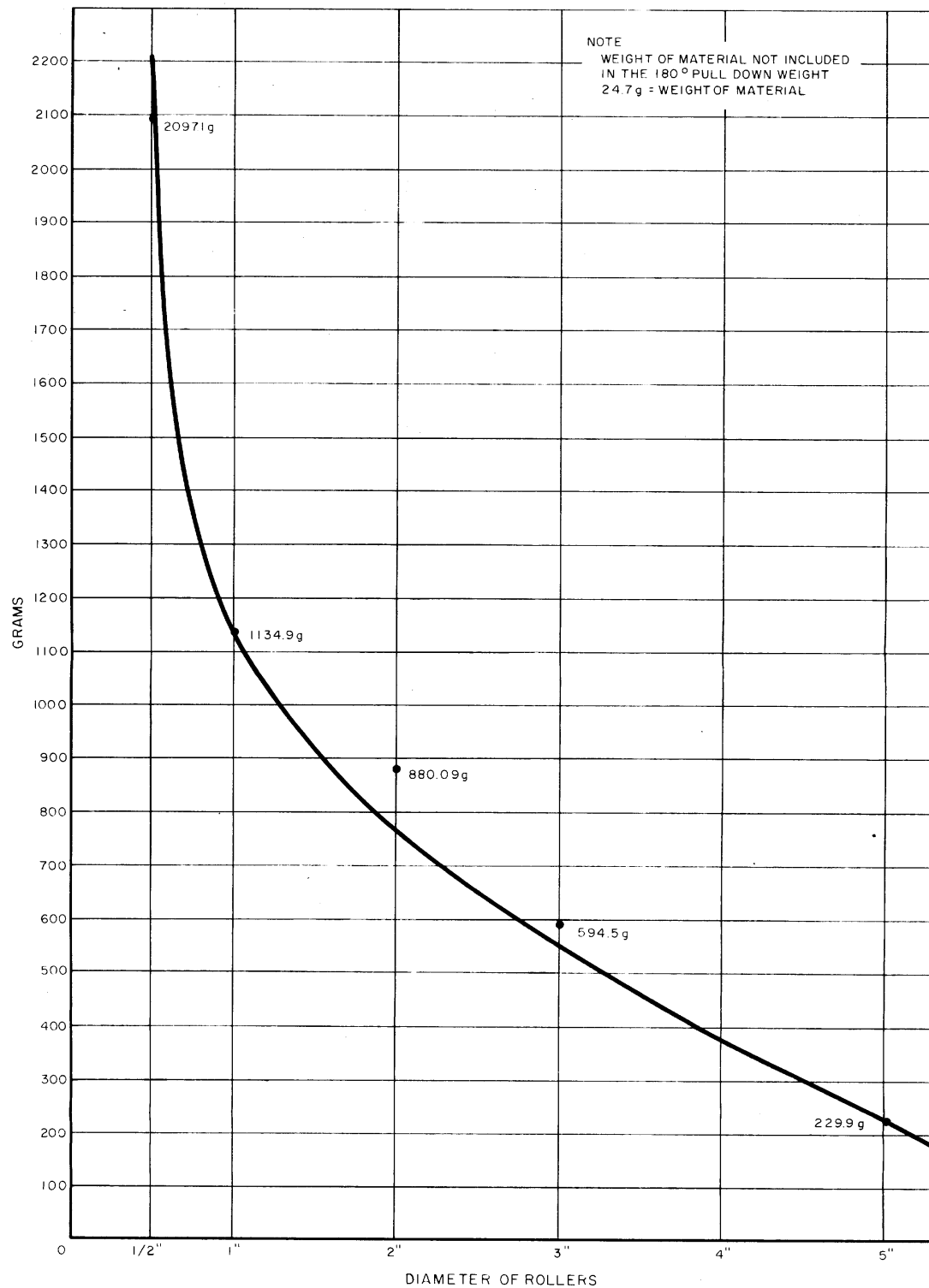
TYPE 8430 70MM X 15" MED-BASE FILM
5.6 MILS - THICKNESS OF MATERIAL
UNPROCESSED

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TYPE 8430 35MM X 15" MED-BASE FILM
5.6 MILS - THICKNESS OF MATERIAL
UNPROCESSED

Figure 8.



LEADER 9-1/2" X 15" HEAVY-BASE FILM
08.5 MILS - THICKNESS OF MATERIAL
UNPROCESSED

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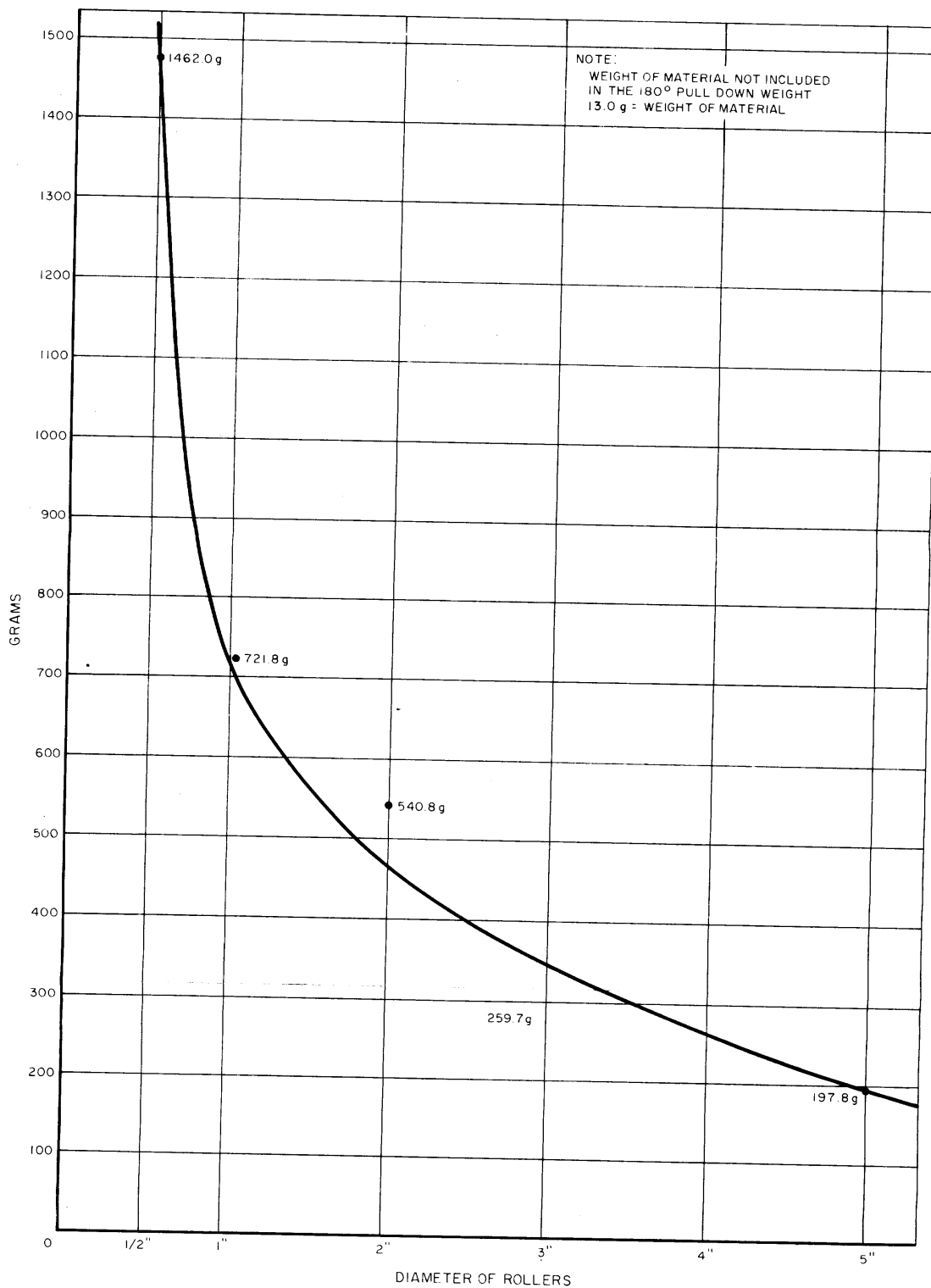
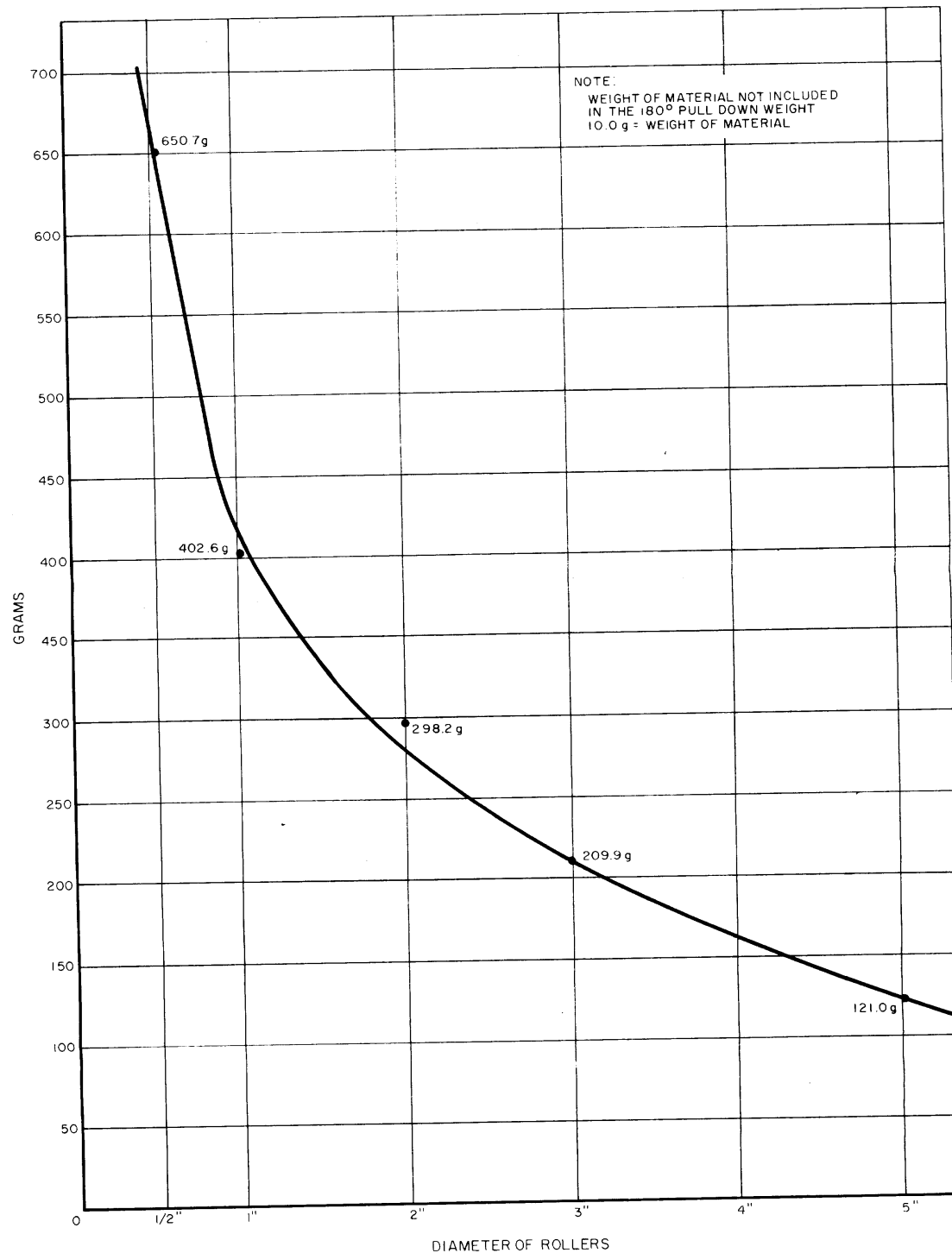


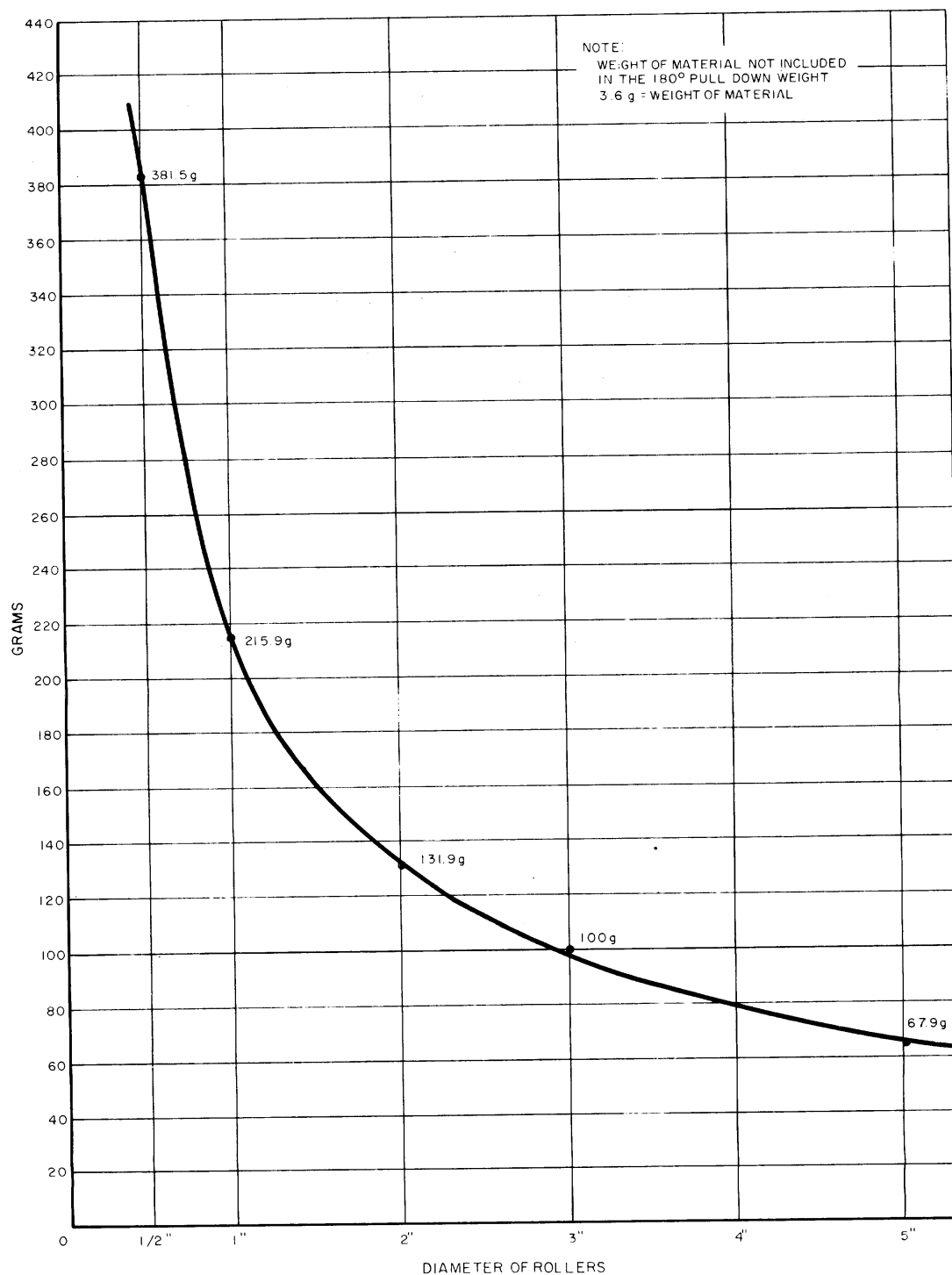
Figure 10.

LEADER 5" X 15" HEAVY-BASE FILM
08.5 MILS - THICKNESS OF MATERIAL



LEADER 70MM X 15" HEAVY-BASE FILM
08.5 MILS - THICKNESS OF MATERIAL
UNPROCESSED

Figure 11.



LEADER 35MM X 15" HEAVY-BASE FILM
08.5 MILS - THICKNESS OF MATERIAL
UNPROCESSED

974-002

Figure 12.

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